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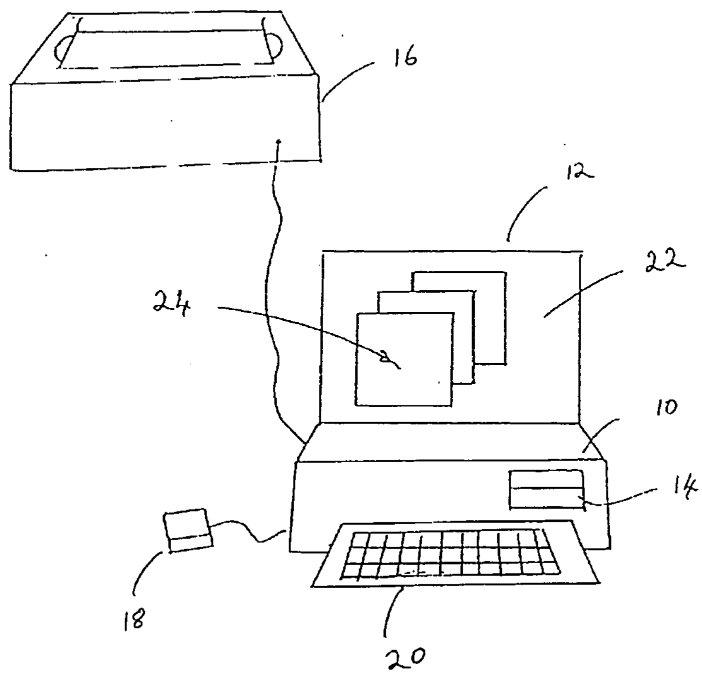
(54) **SYSTEME DE GESTION DE SOINS MEDICAUX PERSONNALISES**
(54) **INDIVIDUALLY TAILORED MANAGEMENT CARE SYSTEM**



(57) Système pour la gestion de la santé comportant plusieurs postes de travail informatisés pour introduire des données sur un patient dans une base de données, pour y accéder à partir d'une base de données et pour les contrôler. On y retrouve également une base de données sur les patients pour recueillir et entreposer les renseignements sur ces derniers ainsi qu'une base de données sur les spécialistes pour recueillir et entreposer les données des spécialistes. Un réseau relie les postes de travail informatisés, la base de données des patients et la base de données des spécialistes. On y retrouve aussi des logiciels permettant d'établir des renvois entre les

(57) A system for management of health. The system comprising a plurality of computer workstations for imputing patient information into a database, for accessing patient information from a database and for monitoring patient information. A patient database for collecting and storing patient information and a specialist database for collecting and storing specialist information are also provided. A network connects the computer workstations, the patient database and the specialist database. Also provided are software for cross referencing the patient database information and specialist database information to select a specialist

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données de la base de données des patients et celles de la base de données des spécialistes afin de sélectionner un spécialiste pour traiter les symptômes du patient, de communiquer entre les bases de données, de surveiller un patient dans un établissement de santé, de contrôler les coûts, de vérifier le temps pris à poser un diagnostique, de vérifier le taux de diagnostiques justes et de protéger les données du système. Sont également fournis l'équipement et les logiciels nécessaires pour alerter le personnel soignant du besoin d'accéder au système et pour la communication entre les membres du personnel soignant.

to treat symptoms exhibited by the patient, communicating between the databases and monitoring a patient in a health care facility, monitoring costs, monitoring time taken to complete a diagnosis, monitoring the rate of successful diagnoses and securing the data in the system. Equipment and software for alerting health care personnel of the need to access the system and communication between health care personnel is also provided.

INDIVIDUALLY TAILORED MANAGEMENT CARE SYSTEM

Abstract of the Invention

A system for management of health. The system comprising a plurality of computer workstations for imputing patient information into a database, for accessing patient information from a database and for monitoring patient information. A patient database for collecting and storing patient information and a specialist database for collecting and storing specialist information are also provided. A network connects the computer workstations, the patient database and the specialist database. Also provided are software for cross referencing the patient database information and specialist database information to select a specialist to treat symptoms exhibited by the patient, communicating between the databases and monitoring a patient in a health care facility, monitoring costs, monitoring time taken to complete a diagnosis, monitoring the rate of successful diagnoses and securing the data in the system. Equipment and software for alerting health care personnel of the need to access the system and communication between health care personnel is also provided.

WHAT IS CLAIMED IS:

1. A system for management of health care comprising:

computer workstations for imputing patient information into a database;

computer workstations for accessing patient information from a database;

computer workstations for monitoring patient information;

a patient database for collecting and storing patient information;

a specialist database for collecting and storing specialist information;

a network connecting the computer workstations, the patient database and the specialist database;

means for cross referencing the patient database information and specialist database information to select a specialist to treat symptoms exhibited by the patient;

means of communicating between the databases and workstations;

means for monitoring a patient in a health care facility;

means for alerting health care personnel of the need to access the system;

means for communication between health care personnel;

means for monitoring costs;

means for monitoring time taken to complete a diagnosis;

means for monitoring the rate of successful diagnoses; and

means for securing the data within the system.

2. A system for management of health care as recited in claim 1 wherein the system further comprises a system manager to monitor progress of the diagnosis of the patient.

3. A system for management of health care as recited in claim 2 wherein the computer workstations are accessed by physicians, specialists, test centers and system managers.

4. A system for management of health care as recited in claim 1 wherein the patient database comprises:

physician input data selected from the group consisting of age of the patient, sex of the patient, symptoms of the patient and a request for a specialist to consult;

specialist input data selected from the group consisting of request for tests to be performed on the patient, analysis of test results and diagnosis;

data input selected from the group consisting of blood chemistry analysis, biopsy analysis, histological analysis, psychiatric analysis;

image input data selected from the group consisting of radiological images, magnetic resonance images, CT images, ultrasound images;

location tracking during testing procedures;

time from initiation of diagnosis to completion of the diagnosis;

treatment initiated in response to the diagnosis;

effectiveness of the treatment;

cost of the diagnosis and treatment; and

status of the patient throughout the diagnosis and treatment.

5. A system for management of health care as recited in claim 1 wherein the specialist database comprises:

the specialty of the specialist; and

a ranking wherein the ranking is determined by accuracy rate of diagnoses, speed of diagnoses, number of cases or procedures undertaken, financial cost of the specialist, re-referral of cases to the specialist and the geographical location of the specialist.

6. A system for management of health care as recited in claim 1 wherein the network connecting the computer workstations comprises a means of connection is selected from the group consisting of dedicated land communication lines, phone lines, microwave links and satellite links.

7. A system for management of health care as recited in claim 1 wherein the means for cross referencing the patient database information and specialist database information comprises software to analyze the probable area of the body to be treated and matching this information to the specialty of the specialist and further analyzing the ranking of the specialist to select a specialist to perform a diagnosis of the patient.

8. A system for management of health care as recited in claim 1 wherein the means of communicating between the databases and workstations is selected from the group consisting of dedicated land communication lines, phone lines, microwave links and satellite links.

9. A system for management of health care as recited in claim 1 wherein the means for monitoring a patient in a health care facility comprises software responsive to input from the health care facility wherein the input comprises data related to the patient's arrival at and departure from the health care facility and arrival at and departure from testing sites within the health care facility.

10. A system for management of health care as recited in claim 1 wherein the means for alerting personnel of the need to access the system comprises a means selected from the group consisting of computer to computer communications and beepers.

11. A system for management of health care as recited in claim 1 wherein the means for communication between personnel comprises means selected from the group consisting of video conferencing and telecommunications.

12. A system for management of health care as recited in claim 1 wherein the means for monitoring costs comprises accounting software.

13. A system for management of health care as recited in claim 1 wherein the means for securing the data in the system comprises:

an access means to enter to system, wherein the access means will allow access to the databases of only a limited number of patient the identities of whom are correlated to the access means of a particular user; and

encryption of data transmitted between computer workstations and databases.

14. A system for management of health care as recited in claim 1 wherein patient data is input into the patient database using a computer generated questionnaire specific for the body area for which the patient has sought treatment.

15. A method of using a system for management of health care comprising:

inputting patient information from a computer workstation into a patient database;

inputting a request for a consultation specialist;

evaluating and ranking specialists;

inputting specialist into a specialist database;

matching a specialist from the specialist database with the patient data in the patient database;

ordering tests to evaluate the condition of the patient;

inputting test results into the patient database;

accessing test results to evaluate and render a diagnosis; and

inputting the diagnosis into the patient database.

16. A method of using a system for management of health care as recited in claim 15 wherein the method further comprises ordering additional tests to supplement data in the patient database so a diagnosis can be rendered.

INDIVIDUALLY TAILORED MANAGEMENT CARE SYSTEM

Field of the Invention

The present invention relates to a method and apparatus for managing the health care of a patient.

Background of the Invention

Currently health care systems have not adequately addressed the problems of escalating costs and widespread access to medical services.

A large section of the population is poor, with inadequate insurance to help finance growing health care costs. Escalating cost often results from an inefficient system that imposes inadequate internal checks and balances. Many factors have been claimed as responsible for increases in health care costs, including self-referrals, age of the population, etc. However, most experts agree that high technology medicine is the leading factor in increasing health care costs. Estimates report that 50 percent of the increase in hospital costs is due to medical technology.

If technical developments are in fact responsible for increasing health care expenditure, then radiology plays a major role in this cost increase. Although it is expensive, high technology radiological imaging procedures, particularly those related to CT/MR provide a better understanding of human anatomy and physiology and many disease processes.

The total cost (C) for an illness is the result of accumulated costs of various procedures performed, visits, tests, etc.

$$C = C_1 + C_2 + \ldots + C_n$$

The cost of each procedure, test or visits (i.e., C_i) in turn is the result of the frequency of resources used (F_i) multiplied by the price of these resources (P_i).

$$C_i = F_i \times P_i$$

The major factors contributing to the costs of high-technology medicine include:

Cost of Examination: High technology medicine in general uses more sophisticated and expensive equipment. Housing and maintenance costs are also often substantial.

Associated Specialists: High technology equipment may require operation and data interpretation by specialists who are more expensive than generalists and primary care physicians (PCPs).

Competing Technologies: Competing but diagnostically redundant examinations are often performed on a given patient. This occurs due to a lack of - cooperation between physicians, preferences according to local expertise and at times financial rewards.

Over-Utilization: Overuse of high technology for profit motives including self-referrals and joint ventures.

The current health care system has significant inefficiencies resulting from lack of coordination between diagnosis and intervention for a given case. These inefficiencies results from: initiating treatment even through a diagnosis is not well established (trial and error); difficulties related to accessing the results of previously performed tests from previous health care providers; financial and other reward mechanisms that benefit the health care provider and/or insurance company, but not necessarily the patient; and administrative activities which provide no direct benefit to the patient such as utilization review, preapproval, and authorizations for "expensive" tests.

Current health care delivery systems are relatively rigid and do not provide the consumer with the traditional degrees-of-freedom inherent in a free-market system. Although there are many physicians and subspecialty services in current health care systems, there is a limited number of "paths" from which individual consumers (patients and referring physicians) can realistically obtain services from individual providers. Thus, for a given patient case, there are few suppliers of either service or technology. This rigid structure contains limited checks and balances to bound the efficiency, accessibility, quality, and cost of services to its potential users. Under current systems, each episode of care creates profit for the provider. This is particularly true when using expensive procedures. Thus, the

number of procedure incidences (N), the frequency of incidences (F_i), and the price of incidences (P_i) are increased. Some solutions to control costs have been developed and implemented by government and third party payers.

Establishment of managed care programs have all been aimed at reducing health care expenditures by reducing utilization and access. Reduced utilization has been accomplished by: not providing easy access to "expensive" modalities (for example, limiting the number of MRIs); implementation of utilization review procedures that critique whether a prescribed examination should be performed; and the development of financial disincentives for PCPs to request performance of expensive procedures (primary care gatekeeper model). This system promotes inefficiencies because of trial and error. Under this system health care dollars are given to PCPs who have the financial disincentive to perform any tests. Thus, many times treatment is initiated without firm diagnosis that results in repeated visits and expensive tests rather than a definitive test when it is necessary.

Although the development of HMOs initially reduced the cost of health care compared to fee-for-service schemes, its rate of increase has continued to parallel that of a traditional fee-for-service system. Of further concern is the degree of dissatisfaction when use is controlled and the patient's choice of selecting physicians and diagnostic facilities is reduced. Such concern with the quality of care has resulted more recently with the establishment of a point-of-service health plan (POS). Under POS, patients have a better choice of whom to see and where to get their diagnostic tests performed. However, there is still a centrally controlled utilization review in place for expensive examinations requested.

Some specific examples of problems which exist in current health care management systems are:

a. PCP Gatekeeper: In this model the PCP is responsible for managing the disease episode of a given patient and deciding about subsequent diagnostic tests, specialists and treatment. Since it is very unlikely that the PCP can be totally fluent in all diagnostic tests and all subspecialties of medicine, the chance of inappropriate selection of diagnostic tests and inaccurate diagnosis increases, resulting in a prolonged work-up and higher costs. Clearly, much of the disease can totally be managed by primary care health care providers including the primary care physician

(PCP), nurse practitioners and other paramedical personnel. However, it is the 10 to 20% of the "complicated" diseases requiring expertise to diagnose which results in extensive costs and must be managed and controlled in a different manner. A primary health care provider should initiate treatment when the diagnosis is certain. When it is not, appropriate consultation should be available.

Access to health care is a major problem in the United States, where over 40 million people do not have appropriate access to health care. The quality care is increasingly being criticized by the report of adverse affects on patients resulting from denial of access and care and focus on inexpensive care. Although there has been an initial reduction in expense as the result of HMOs, the rate of increase has paralleled traditional non-managed care. None of the solutions thus far have resulted in appropriate reduction of expenses or appropriate increase in access.

Therefore, there is a need to provide a means of accessing the health care system which will reduce cost but which will increase the quality of care provided to patients

Summary of the Invention

The present invention is directed at a system and method for the management of health. The system comprising a plurality of computer workstations for imputing patient information into a database, for accessing patient information from a database and for monitoring patient information. The workstations are at local or remote location and allow sharing of patient information between a variety of health care personnel. A patient database for collecting and storing patient information and a specialist database for collecting and storing specialist information are also provided. A network connects the computer workstations, the patient database and the specialist database. Also provided are software for cross referencing the patient database information and specialist database information to select a specialist to treat symptoms exhibited by the patient, communicating between the databases and monitoring a patient in a health care facility, monitoring costs, monitoring the time taken to complete a diagnosis, monitoring the rate of successful diagnoses and securing the data in the system. In addition equipment and software are provided

for alerting health care personnel of the need to access the system and communication between health care personnel.

Brief Description of the Drawings

The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood with reference to the following description, taken in connection with the accompanying drawings in which:

FIG. 1 illustrates one possible embodiment for implementing the present invention;

FIG. 2 is a flow chart illustrating one prior system;

FIG. 3 is a flow chart illustrating another prior system;

FIG. 4 is a flow chart illustrating the present invention;

FIG. 5 is a flow chart illustrating the present invention; and

FIG. 6 is a flow chart model illustrating the present invention.

Detailed Description

The present invention is directed at an electronic infrastructure coordinating local care provided by PCPs and consultation from national and institutional experts. The most important effect of the new system is to provide an easy-to-use electronic infrastructure by use of "gateway" software and new databases to, for the first time, allow coordination of various episodes of care. The system can be adopted for use anywhere in the world where computers and communication lines are available.

The present invention is directed at the 10 to 20% of cases where the cases are considered to be complicated. In the other 80 to 90% of cases traditional care is recommended.

The invention creates an electronic infrastructure and database in three levels: local; regional; and global;. Newly developed "gateway" software allows seamless communication between various elements in a cost-effective manner. Unlike all other managed care systems, this invention encourages use of technology, tailors the care to an individual patient, removes the barriers of access such as utilization review and does all of this at a low cost to society.

I. Overview

FIG. 1 illustrates one possible embodiment for implementing the system of the present invention.

The present invention comprises a computer-implemented system that assists a primary health care provider through the process including (1) diagnosis, (2) health care system designs, communication, quality assurance programs, and (3) therapy. It includes a system for diagnosing and developing a therapy.

The system typically operates with computer or network of computers **10**. It is envisioned that attached to the computer is monitor **12**, disk storage **14**, and printer **16** peripherals. Also included in the preferred embodiment are input devices, for example, mouse pointing device **18** and keyboard **20**. In addition, the computer operates under the control of an operating system **22**. The system includes a suite of computer programs **24** and databases or files operating under control of the operating system **22**.

The system **24** is an information technology enabling a user to have immediate access to the integrated information, guidance, advice, assistance, training and diagnosis tools required to establish and develop a specific (1) diagnosis, (2) health care system designs, communication, quality assurance programs, and (3) therapy. The system process adherence seeks to continuously improve health care provision. The system is designed to help the user tailor patient information to meet diagnosis and therapy requirements and to incorporate diagnosis and therapy input early and often throughout the provision of health care.

The system **24** is a flexible tool that can be used to analyze a health care problem and its (1) diagnosis, (2) health care system designs, communication, quality assurance programs, and (3) therapy in phases, and to make rational health care decisions about how to meet the therapy needs.

The system **24** is modifiable and configurable, thereby allowing the user to model almost any health care scenario and to implement the system **24** to fit any health care situation. Users can configure and define the system **24** by adding, modifying, or deleting any of the system **24** components, i.e., phases, and activities

of (1) diagnosis, (2) health care system designs, communication, quality assurance programs, and (3) therapy.

The computers and the network for the system **24** can be interlinked through the use of "gateway" software and appropriate technique so that communication with regard to diagnosis health care system design and therapy can be communicated between the PCP and the specialist group. The computer of the system **24** can have programs for predesignating and sorting diagnostic data and information about a patient so that there is a selection particular subgroups of specialists within the group to which a patient's data is automatically routed. Thus, in a situation where the data represents information relating to pediatric care, the pediatric subgroup of the specialty group is selected to the exclusion of geriatric personnel. The computer may affect even further more disease orientated divisions and selections automatically as required. For instance, the computer can have a number of different therapies which can be excluded and/or included for different indications.

II. <u>The System</u>

A PCP provides a patient consultation generally according to a first tier. Then a second tier diagnostic work-up is initiated. The second tier diagnostic evaluation depends on using global subspecialties.

The first tier diagnosis is a system of local medical care. This includes local PCPs, nurse practitioners, paramedical personnel, etc. These health care providers may vary from site to site, but they are responsible for the development of the personal physician-patient relationship, including gaining the patient's confidence and trust and be a reliable consultant to the patient.

The second tier is remote. This second tier system is developed around a specialty practice of a group of physicians specialized in imaging and who do have background in the clinical practice of medicine.

The second tier includes: Pediatric Imaging and Diagnosis, Neuroradiology Imaging and Diagnosis, Head & Neck Imaging and Diagnosis, Gastrointestinal Imaging and Diagnosis, Breast Imaging and Diagnosis, Musculoskeletal Imaging and Diagnosis, and Cardiovascular Imaging and Diagnosis. For example, a pediatric

radiologist is a person who not only knows radiology and how to use the various technologies available for imaging, but also knows enough about pediatric diseases.

The subspecialty imaging is integrated using a system design and software to integrate various components of the health care delivery system in an automated fashion.

Comparison of the primary care gatekeeper model and a fee-for-service health care system is provided to show the intrinsic difficulties and inefficiencies of the existing systems. A description of the existing systems are provided in FIGs. 2 and 3, and further explained with reference to FIGs. 4, 5, and 6 which show the present invention.

III. Prior and Existing Systems

FIG. 2 illustrates a fee-for-service system. In this system the patient may see a specialist or primary care physician who in turn may not obtain specialist consultation. Even a brief evaluation of this system clearly shows that various elements of health care are not coordinated and there is significant financial incentive for over-utilization by physicians. In other words, this is a disorganized system with no particular infrastructure and is driven by illness (the sicker the patient, the more money people involved in the system make) and is inappropriately expensive.

FIG. 3 illustrates typical managed care. Under this system expenses are controlled by making the primary care physician "manager" of the patient and providing financial incentives and penalties to primary care physicians not to use technology and consultation in order to reduce costs. There is a potential conflict between what is good for the patient and the financial requirements of this type of managed care. Again there is no infrastructure or coordination between various aspects of care for a given patient. Thus, the system, although less expensive the FIG. 2 system, it potentially has lower quality and is based on reduced access.

In FIG. 4, there is shown a system in accordance with the invention, where the patient starts by interacting with the PCP. The PCP then follows a procedure as indicated in the extended column towards the middle of the page of FIG. 4. If the PCP can perform a treatment after analysis and diagnosis, this is provided as

indicated. If the PCP is unable to determine what is wrong, the system is applied to develop a consultation with a group of specialists, namely the case manager (CM). The system guides the process down the main column where the PCP alone is doing the diagnosis and therapy. The system also guides the process where a CM is involved. The system provides for a streamlined approach to diagnosis and therapy regimens. The PCP has available a bank of specialists in the group providing for streamline diagnostic testing and therapy.

The system of the invention is further illustrated in FIG. 5. There is shown a streamlined flow diagram where the PCP provides a diagnosis in relation to basic diagnostic tests for the patient. If successful, therapy is complete. If not, the PCP consults with the CM which has the selected group of subspecialties. The system can select the appropriate subspecialty as necessary. Following the final diagnosis, follow up and therapy is recommended. In other situations, other specialties outside of the subgroup are selected for the therapy purposes.

In FIG. 6, a more detailed representation of the system is set forth. This system is described relative to the cost factors, and in relation to global telemedicine where the subgroup of the case manager uses imaging to ultimately arrive at a diagnostic conclusion. Thus, the invention follows a systematic process model for health care (similar to that applied in the automotive industry) based on an electronic infrastructure and coordinated care.

IV. GENERAL

As can be seen in the process model, the patient always sees a local health care provider who can take care of the patient's problems confidently in many instances. If a diagnosis is not clear, then consultation is obtained from the Case Manager (CM) pool. This CM pool includes specialists. The CM is in constant contact with the PCP and other local care providers until diagnosis is accurately established. This would eliminate trial and error treatment and require accurate diagnosis.

Under the system when an accurate diagnosis is made, then either the patient can be managed by a local PCP or would require referral to another specialist. Many of the referrals when acute are surgical. Thus, the patient is referred to a

surgeon who would concentrate on doing surgery and not spending unnecessary time to worry about things that are not their strength. For instance, the invention would avoid a neurologist doing ultrasound.

If the patient has a chronic illness, then help is obtained from local existing societal resources such as churches and other religious and volunteer organizations.

The system process model is supplemented by a data model include those specifically related to costs. This data model allows removing redundancies, using expensive imaging modalities efficiently, and allowing for detailed evaluation of various steps related to health care management costs.

If successfully implemented, the patient would have the comfort of having their own local health care provider who they know (family physician). Specialists are readily available, no matter where the patient is located, using teleconsultation and telecommunication.

Higher quality health care is provided by the system for patients and there are potentially lower costs, no gatekeeper, utilization review, and other administrative burdens undesirable for the patients. Specialists who are focused on doing what they do best for treatment of the patient, when such treatment is indicated.

The system is expeditious and more accurate in (1) diagnosis, (2) health care system designs, communication, quality assurance programs and (3) therapy. There is a high-quality work-up and other advantages to the patient such as less time required away from work or routine duties and anxiety associated with uncertainties related to diagnosis, etc. The patients continue to have their close contact and rapport with their local community family physician on one hand. On the other hand, the advantages of a one-stop multi-specialty group practice and case managers from the highest quality universities faculty.

V. <u>ADVANTAGES OF THE SYSTEM</u>

In accordance with the present invention, the primary health care providers focus on doing what they are trained to do; that is to be a primary health care provider. Many patients are diagnosed readily by a PCP and treated for simple problems. However, when a PCP has a diagnostic dilemma, rather than deciding

on complicated tests and technology with which he/she is not totally familiar, the PCP consults remotely with specialists. These subspecialist include chest, GI/GU, neuro, ultrasound, head and neck, pediatrics, breast, and musculoskeletal radiologists. For example, a pediatric radiologist is generally a radiologist who is trained not only in radiology but also in pediatrics; a neuroradiologist is a physician who is not only trained in radiology, but also is familiar with brain diseases and its clinical presentations. The procedure is designed to avoid trial and error when the PCP is presented with a complicated disease.

The present invention encourages PCPs to do what they do best, namely primary health care and substantially redefines the contract between referring physician and the consulted diagnostic specialist. First, the nature of the request can be literally taken as: "Given the accumulated diagnostic data for the patient, please tell me what's wrong with him/her." There is no specification as to how the diagnostic specialist should do his/her job. Secondly, nonspecific diagnoses will not be allowed as an endpoint to a diagnostic consultation service.

The consultation service promotes the diagnostician to continue to be in charge of the patient until a confident diagnosis can be made and reported back to the referring PCP. The diagnostic specialist not only determines what tests should be performed, but also continues with a sequence of tests until a confident diagnosis can be reached. Furthermore, as part of the consultation contract, a time limit to the diagnosis is prescribed. (The diagnostician thus must be aware of the resources and personnel within the site where tests can be performed so that they can be schedule efficiently as many tests may be necessary during a single patient visit).

The health care delivery system of the present invention is free (or relatively free) of the various rigid bounds present in current systems. The major features of the system of the present invention are as follows:

Local Primary Care Health Care Providers: These physicians or primary health care providers are paid per episode of care. Thus, the incentive here is to see more patients and create more patient satisfaction. Thus, the most important incentive is to make the diagnosis accurately and create patient satisfaction. There is no penalty for obtaining consultations for the purpose of diagnosis when needed. There is no financial reward for not performing tests for patients when they are indicated.

Imaging Cornerstone: All imaging expenses are paid on a capitated basis to provide facilities, system designs, and communication methodology. Thus, the incentive of the system itself is to do the least possible. However, there are ongoing requests from PCP to do more, thus the incentive of the system is to provide the most efficient and expeditious diagnosis.

Imaging/Diagnostic Consultants: The financial incentive for this group of physicians is to do more. They are paid (or their institution is paid) per episode of care. Thus, the incentive would be to provide consultation as rapidly as possible before others can get hold of the case. Thus, efficiency is created by rapid response. In addition, the system monitors the accuracy of the consultations, who in turn become responsible for receiving or not receiving consultation requests.

Thus, the incentive of the PCP is to create more patient satisfaction that equates to more accurate expeditious diagnosis. The incentive of the system itself is to create a more cost-effective method for expeditious and accurate diagnosis. The incentive of the consultants is also to be not only accurate but cost-effective by providing, timely diagnosis and consultation at a competitive rate. As a result the net outcome is more cost-effective, accurate and expeditious diagnosis for the patient.

Example 1

A Working Example of an Individually Tailored Management Care System

The working system has been developed for Pediatric Radiology. The system has been integrated with other remote sites within the same institution. The architecture of the system has been developed to address the following issues: (1) improvement of system connectivity through adaptation of standards such as the ACR-NEMA DICOM 3.0 standard, (2) improvement of overall system intelligence and process coordination through a common information processing model, (3) increase of system workload capacity by implementation of high speed networks, mass storage devices, hierarchical storage algorithms, data compression methods and faster computer CPU's, (4) facilitation of system maintenance by use of graphical CASE (Computer-Aided Software Engineering) tools for process modeling and system design, (5) improvement of system reliability by development of centralized system monitoring and recovery software, and (6) improvement of clinical operation through implementation of clinical quality control protocols. A summary of the developments of some of the important prerequisition technologies to a wide-area system is presented below.

Image Acquisition: A substantial library of interface software from a whole spectrum of medical manufacturers (17 medical imaging systems so far) has been compiled and provides a proven base from which to interface to future medical imaging devices. A library of software interface routines from over 7 different types of interfaced medical imaging systems has been developed. This library is maintained using graphical CASE management tools.

Network Services: Over 60 system nodes are managed. Also, an extensive software library of communications software for transmitting images and for recording transaction logs for performance and reliability assurance has been developed. This library is maintained using graphical CASE management tools. System software for monitoring all system processes and automatically warning the system operators of potential problems, and restarting processes that have failed.

Image Archive and Distribution Services: The Image Archive and Distribution Services are responsible for reliable archival of all acquired system images and for the timely retrieval and intelligent distribution of images to appropriate workstations. The Image Archive Services includes the following intelligence: migration strategies for image files among a three-tiered storage hierarchy; image compression methods; and image file format conversion algorithms. The Data Distribution Service receives triggers from Hospital Information System (HIS) and radiology Information System (RIS) events (e.g., patient arrival, study complete, dictation complete) to activate image prefech algorithms from the Image Archive Service, folder management software for compiling both current and relevant historical images for a patient, consistency checks for image and patient descriptions, and routing algorithms for placing imaging studies onto appropriate radiology and clinical workstations.

Currently, about 2.4 Terabytes of image data from over 40,000 patients have been archived at a present rate of 4.0 Gigabytes per working day from 17 scanners.

System Workstation Services: Numerous display workstations, including five commercial, high-quality, high-brightness, IK workstations from Siemens Medical Systems for use is gaining clinical experience on workstations, ROC studies, user-interface design research, and multimedia research in radiology are included in the system. Such workstations are used in pediatric, gastrointestinal, thoracic, bone, and neuroradiology departments.

Workstation software includes graphical CASE tools for rapid development of X-windows user interface screens (X-Designer, ObjectWorks, and Visual C++), a library of high-level call back routines for accessing image lists, display operations, processing operations, RIS information, and HIS information, and a library of graphical icons representing various pieces of data, image processing operations, and information search operations.

Teleradiology Service to Melbourne, Florida: A capitated teleradiology has been implemented for a well defined population (20,000 employees of a corporation) in Melbourne, Florida. Image transmission is performed over a T_1 communication line. Currently, MR and CT imaging studies are read at UCLA and reported back to Melbourne.

Evaluation of data in comparison with previous systems allows demonstration that utilization of high technology modalities such as MRI and CT has increased. A review of the requests for such studies found that no studies were performed inappropriately. This indicates that the patients did not receive their appropriate number of MRIs on the previous system because of utilization review and financial concerns.

Patient satisfaction is extremely high, physician satisfaction with the quality of care is high, and the employer is more satisfied than before.

There has been significant financial savings to the employer both in terms of direct payment for imaging and in terms of indirect savings because patients are diagnosed more expeditiously and returned to work sooner.

Wide-area Technologies

WAN Communication: A feasibility study was conducted for a teleradiology network connecting the UCLA Medical Center with two local hospitals, Olive View-UCLA Medical Center and Harbor-UCLA Medical Center, each about 20 miles away. A survey of available Metropolitan Area Network (MAN) and Wide Area Network (WAN) technologies and associated costs, including T_1, dial-up DS-0, dial-up DS-1, DS-3, ISDN, and microwave links was performed. The use of an ATM (Asynchronous Transfer Mode) network designed to provide greater network capacity with higher reliability between UCLA, Olive View, and the VA hospitals in Los Angeles and a T_1 and a satellite-based WAN to support increased a real coverage and workload are also involved.

Integration of distributed heterogeneous databases: This layer manages the integration of data from various medical databases as well as provides methods to distribute data to outside users. Selected information from the HIS system is automatically forwarded to the RIS.

The software is composed of four classes of data integration CASE (computer-aide software engineering) tools: (i) global schema designer, (ii) communication utility to access data on remote database systems, (iii) data translator, and (iv) job-flow designer. These tools allows the performance of rapid evolutionary integration of these database systems. Low level C++ code is

automatically generated from high-level graphical specifications for data access and translation. Currently, the collection of the HIS data takes about 60 seconds while RIS information takes about 40 seconds. The system is currently being refined to improve performance by use of a global data cache. A user presentation screen for HIS and RIS data has been implemented, tested, and placed in clinical.

Insurance Arrangement: The patient population consists of all employees of the corporation located in Melbourne, Florida. These patients sign-up for a capitated health care contract with the employee benefits office. Under this arrangement, set monthly fees are collected for agreed medical services. For example, the employee is charged $10.00 per month for radiology services. In general, due to economy of scale, the greater the number of employees that sign up for this plan, the lower the capitated payments for individual services.

The corporation gives a large percentage of this money to a health management company. Most patients are healthy and the lump sum of money input is greater than the accumulated costs for services required for its clients. Thus, the health management company is motivated to keep their clients as healthy as possible in order to minimize the consultation dollars spent on capitated services.

Patient visit to the PCP: When a patient requires medical attention, he/she visits a PCP. The selection of which PCP is based on the patient's choice. Payment is based on a fee-for-service or point-of-service arrangement. A number of PCP's in Melbourne, Florida, agreed to participate in this study.

The PCP performs a history and physical on the patient in the usual manner. If the PCP needs a consultation, he or she decides: (1) does the patient need a psychiatric consultation, or (2) does the patient need an organic physician consultation. When the PCP uses the system for a consultation, radiology and psychiatry services are capitated and freely available to the PCPs. Thus, the unlimited free availability of subspecialty services promotes more frequent usage of the services. Increased usage of diagnostic subspecialists improves the quality of diagnosis.

Since the subspecialty diagnostic services are performed remotely, there is little chance of a subspecialist "stealing" the PCP's patients. Furthermore, as a PCP becomes aware of the capabilities and ease-of-access to these subspecialists, patients

will learn of the PCP's reputation and access to resources and thus will draw more patients requesting his/her service. Thus, there exists compelling reasons for PCPs to use the services. It is assumed, that the more frequently the PCPs can consult with world experts, the more notable their own reputation becomes within the community.

Specialist: Subspecialists are paid a nominal rate on a fee-for-service basis. Implicit in the proposed telemedicine network are intelligent decision-makers that are based on medical information logic. The telemedicine logic is a case-based decision support system that audits the performance and decision-making tasks of all subspecialty service providers within the medical federation. The system has a built in priority rating system that awards jobs to those subspecialists that have a history of providing quality service in terms of: 1) communication, 2) quality of diagnosis, 3) directiveness to diagnostic conclusion and 4) expediency.

In addition, the system tracks the availability of all subspecialty providers within the system and has built in agents to assist in the progression of patient cases. Jobs are assigned only to subspecialty providers that follow system protocols and that are available for responding to consultative requests in a reasonable time period.

The consultation must be followed through until a more or less definitive diagnosis is made. The system is driven by the principle that in the long run, it is best (for the patient and in terms of overall health care costs) to avoid a detrimental treatment-evaluation cycle and attempts to oversee that such a pattern of patient care is avoided. The system must be able to forecast the expected expenses of a nonspecific diagnosis and possible ramifications it may have on the entering into a treatment evaluation cycle.

Reviews Patient Requisition: A requisition originates from the requesting PCP site (Florida). The requisition contains information compiled by the PCP using the Referral Assistance Program obtained via template questionnaires.

Review Patient's Medical Record: A HIS-RIS PACS interface is used in the study. From this interface, radiological images may also be viewed. All relevant records for the patient are gathered from remote sites by the Case Preparation agents. The data is stored in a local DBMS which conforms to a system-wide generic medical record data model.

Make Inquiries to the PCP: Upon reviewing the requisition and patient's medical record, a specialist may have additional questions of the PCP about the patient:

Is patient vomiting? yes ___ no ___ don't know ___

Has patient lost weight? yes ___ no ___ don't know ___

Is abdominal distention one or two days or more?

yes ___ no ___ don't know ___

This communication is performed either asynchronously using electronic mail or synchronously using teleconferencing software. A teleconference session can be established that features continuous retries and a connect alarm.

Request a Diagnostic Test: instruct that the local patient site perform a diagnostic test on the patient. The specialist decides if the patient needs, for example, an abdominal CT with contrast. This goes to the PCP's scheduling desk which in turn schedules the patient for center X. When scheduling occurs then both center X the specialist are notified of the time of arrival. A customized menu system for each site where services are offered that allow the radiologist to specify precisely the type of examination that should be performed. A remote X-windows application is started that allows the specialist to directly communicate with the Resource Manager and Scheduler at the patient-location site.

Communicate with the Imaging Center: The specialist sends an electronic message to the center indicating that the patient should, for example, have a spiral CT with the first spiral after half of the contrast is injected and the next spiral after all of the contrast is injected. Specific attention should be made to adrenal gland, kidneys, and the liver.

Remotely Monitor an Imaging. Study: The specialist can remotely monitor an imaging study in real-time using video transmitted from the imaging equipment located at the patient site. Alternative modes of establishing a real-time communication channel such as phone, beeper, etc. are also employed.

Detailed Viewing and Processing of Imaging Study: Images from the requested studies are sent to the specialist's teleradiology workstation. Comparison images have already been forwarded by the Case Management software during the initial service request. The specialist reviews the imaging study from his

workstation and narrows the working diagnosis between, for example, Wilm's tumor, neuroblastoma, hepatoblastoma, hydronephrosis, and potentially heinangiomas.

Recommend Follow-up Studies: At this point, one of two things may be present a) Patient has hydronephrosis, therefore, delayed films are obtained and the degree of obstruction is assessed; b) Patient has a tumor in which case a chest CT is also obtained.

Construction of Final Report: A final diagnostic report with therapy recommendations is prepared and directed to the PCP at the requesting site. A key image summary report is available both in electronic and printed form. Note that the consultation with specialist is not terminated until a final diagnosis is determined. Ideally, all necessary diagnostic tests are performed as soon as possible (possibly all in a single day). Thus the monitoring of the patient's location and status at all times during their hospital visit is necessary.

Other alternatives in patient management include:

Mass screening: A radiologist reviews all images for a day at one screening. Here the image transfer is not real-time but the image data quantity can be quite large.

Remote Reading: A radiologist reviews the image while the patient is in the clinic, providing immediate feedback to the technologist.

Interactive Review: Two or more people in different locations both see the same image and can interactively highlight problem areas or add annotation.

Image Management: Images are transferred and shared within sites, between collaborating sites, and between systems.

Image Reference Databases: Past images are used for diagnosis and training.

Implementation Plan

The PCP examines the patient and at some point decides that a consultation with an "expert diagnostic service" is necessary. Within the system, there are many expert diagnostic services from which to choose. The type of consultation request made by the PCP depends upon several factors that may be regionally based (i.e., anatomical concerns) or systemic (i.e., generic concerns). For example, a 60 year old male patient with difficulty in urination and weight loss, may require both a genitourinary tract consultation and a cancer consultation.

To facilitate the selection of the appropriate subspecialty service for a given patient case, the PCP uses the proposed "Referral Assistance" computer program that facilitates the communication process between the PCP and specialist. Use of the program is as follows: After the patient's age and sex are entered, the program begins by asking the PCP to define the body region where the patient symptoms and/or major complaints are present. (e.g., body region "head" for symptom "headache"). The relevant patient history, results of initial laboratory results and impressions are then entered by the PCP.

The patient's chief complaint, the reason the patient has come to see the PCP, is input by the PCP.

A region-specific electronic questionnaire follows which asks appropriate screening questions for the selected body region. These basic screening questions are needed for the system to gather sufficient information to make intelligent decisions regarding the appropriate specialist that should be consulted and/or diagnostic work-up that is best advised for the patient.

Once the appropriate questionnaires have been completed, the Referral Assistance software constructs a consolidated patient screening report. This screening report is then sent off to a Global Service Registry Program for matching, this patients case to the appropriate specialist.

The PCP initiates a service request for the system to return the best candidate specialists for the present patient case. The completed electronic screening form is forwarded to a software system, the "Central Service Registry". The Central Service Registry is a database management system that maintains an up-to-date directory of all available services within the federation of health care providers.

The system relies on a competitive free-market model of health care. Thus the system rewards those health care providers that can provide high quality, expedient services at the most reasonable cost. A priority scoring algorithm is developed based on a number of factors including: Does a given specialist's expertise match the problem area of the patient? The Central Service Registry uses the screening form to correlate the patient's symptoms and previously utilized services to the services enlisted in the registry. The Central Service Registry constructs a ranked list of appropriate subspecialists within the federation that match the service requirements of the patient case under consideration.

What is the availability of the specialist? The availability of each of the services listed in the matched list are determined by consulting with a Resource Management Program, "resident" at each local site.

Has a given specialist previously seen this patient? The Referral Assistance software automatically consults the "Case Management" program, local to its site, to obtain a list of previously consulted specialists seen by this patient. This is an important factor in its decision-making algorithm to maintain good continuity of health care services for a given patient the same specialist should be consulted whenever possible.

From the Referral Assistance Program, the PCP selects the most appropriate specialist from the returned recommended list. This initiates a "request-for-service" message to the remote specialist's site. This message is directed to a "Case Management" Service. At this point, a contract-of-agreement is presented to the specialist which explicitly states his patient responsibilities for the given patient.

The system uses the data supplied by the PCP and the internal database of the specialists' performance to select the most efficient provider for the case at hand. The PCP's report, at the outset, identifies a subset of providers from the total pool who are specialists in the area of the current case. A mechanism is also in place for the system to check the availability of any specialist. A cost function is defined for each available subspecialist based on the following attributes:

<u>Accuracy of diagnosis</u>: This is the most important attribute which determines the selection of the specialist. Accurate information is based on the previous cases assigned to the specialist. Data from pathology reports are compared to the

diagnosis from the specialist. The system database includes information from pathology reports and thus can automatically score the specialist on a case by case basis.

Speed to diagnosis: The total time taken for the specialist to arrive at a definite diagnosis is also determined, with shorter times receiving higher scores. Besides the overall time to arrive at the definite diagnosis, the system also uses other response times to grade the specialist's performance. This will include the time taken to recommend follow-up procedures, availability of the specialist for real time monitoring and response to queries from PCP.

Number of procedures/case: This is a complicated question as it depends on the case. There is, however, an internal monitor from the system as to the number of procedures that a specialist requests over time. The system determines the average number and cost of each procedure for similar cases handled by different specialists. If a specialist exceeds this average a negative score for this attribute is allocated. However, the weighting for this attribute is much less than those listed above.

Financial cost of providers: The system also maintains a record of the total fee per case handled by each specialist. It is given a moderate weighting in the total cost function but forces fees to be at a competitive level. Care is taken to weigh this attribute in a way that prevents specialists with a very low fee/case but with poor accuracy in diagnosis from being selected.

Re-Referral of cases: If a specialist returns a case to the PCP/system without providing a definite diagnosis at any stage the system allocates the case to another specialist. The system also keeps a tab on all cases that a specialist returns without a definite diagnosis. If the case was provided with an accurate diagnosis by another specialist, this serves as a negative mark for the specialist who returned the case. The system will, however, not penalize the specialist if the case is returned to the PCP without a definite diagnosis from several providers.

Geographic location of provider: All providers at remote locations are given the same weight. However, radiologist(s) at the local location are given a higher weight. This ensures that most routine cases go through the local provider, who typically is a general radiologist. Further, unlike the specialists at remote locations

the local provider is not penalized for returning a case without a definite diagnosis. This encourages use of the services of the specialist when the case is beyond his/her area of expertise.

A number of the attributes listed above are not available for a provider who has recently joined the pool of specialists. To facilitate the selection of new recruits, a provider profile is submitted to the system. An electronic query form is constructed to form a profile from the responses of the providers. The first few cases are allocated based on this profile. However, as the provider handles more cases through the system, emphasis for the selection is based on data acquired for the provider's performance.

A large amount of data has to be collected for each case and all the specialists. A mechanism is in place for automated accumulation of this data. Some initial collection is based on electronic forms sent to the specialist at the completion of each case. Attempts are made, however, to obtain information automatically. For instance, accurate information can be obtained by a comparison of the specialist and pathology reports. In addition, an external audit of the specialist's performance is done by a panel of experts on a semiannual basis.

Many different skills are required to locate and access complex information in a widely distributed network of resources. To obtain information from a database (a primary goal), many secondary tasks (subgoals) must be performed: locating the appropriate database; obtaining authorization to access the environment; understanding the structure of the specific database; formulating relevant requests in an appropriate language; using those request to acquire the information; and interpreting the results.

The information processing architecture of the telemedicine system includes three conceptual layers as described by the Internet Research Task Force on Resource Discovery and Directory Service. It consists of an information gathering layer, an information dispersion layer and information interface layer.

The information gathering layer is responsible for collection and correlating data from various heterogeneous medical data repositories including RIS, HIS, and the system. This layer serves as a mediator between a PCP's request for information and implementation servers that access the information. PCPs initiate

patient requests by handing off a pre-compiled form to the data access mediation layer. The PCPs workstation asks "Please fill in all the necessary information on this form for this particular patient. The form corresponds to HIS, RIS or system viewer.

The Information Gathering Layer contains a collection of data access agents which are essentially programmed software robots that know how to access the network, make session connections with various database servers, navigate through these databases to access select data items and translate data from a source to target format.

The mediation layer accepts the form, checks the status of the system, which include network connections and various database servers. The Mediation Layer contains a process that monitors the state of the resources required to access patient data. These resources include network circuits, storage devices, computer CPUs, and various database server processes. Based on the services available, it dynamically creates a real-time plan, dispatching the appropriate data access agents to best accomplish the data retrieval task. The mediation layer serves to hide the heterogeneous and distributed nature of the data from the client. Note that there are all types of database servers on the network that include SQL servers, DICOM archive servers, HL-7 servers, RIS applications and various gateways and commercial applications to the system.

An intermediate query language (IQL) capable of representing the bulk of the requests for information is based on user- or application-level concepts rather than on the concepts or the structure of any particular database.

The information dispersion layer is responsible for any required replicating, distributing and caching of the data to improve access performance and reliability. A data caching algorithm is important, because some agents take several minutes to return records from distributed hospital information system. The caching algorithm uses event triggers from various events including: request for consultation, patient arrival, and explicit requests for patient data. Third, the Mediation Layer contains a global information cache. This cache is a redundant storage subsystem for currently active patients. It provides a method for storing patient records with highest probability of access onto a fast retrieval system.

The dispersion layer and user interface of the system is implemented using the Lotus Notes data management environment. Lotus Notes provides a powerful means of storing, communicating, and formatting/presenting data easily across multiple heterogeneous Computer platforms:

A medical image can be represented by an icon on the report form. When the doctor wants to examine the image, he/she can simply click on the image icon to display the image.

Documents and objects can be linked to the report. When the reader needs the information, he/she clicks on the corresponding icons to retrieve the objects.

An object on the form can be hidden from readers. It can be activated (revealed) when it is necessary or desired.

Certain information can be filled automatically given sufficient data. These data can be packed and sent to other non-Notes application to retrieve more information.

An application is launched in the background to periodically update certain information, either by checking a live database, or by some trigger such as incoming messages.

Some actions can be activated when certain events occur. One example is to notify interested parties that work has been completed.

Information can be passed along to a group of people in a certain order. Each person in the group provides the information required.

Notes can export data to external applications. Certain information can be sent from within Notes to non-Notes database.

Notes provides full text search within the document.

A report can be stored in a database so everyone in the group can view or modify the report. It can also be sent to a specific person so that person is able to view or modify the report.

The information interface layer is responsible for filtering the data as required by different users. This includes organizing and displaying relevant information to the user's general knowledge domain. A simple filtering programming is developed to present only those records that are more likely to be

required by the diagnostic specialist. This layer is also responsible for administering data access control.

Data Security

Patient data must be protected against unauthorized access and tampering. The basic security system is centered on the concept of "access tokens". In this scenario, when a remote request for service is issued, the requesting site issues a token to the remote site for accessing the local patient database. The token is only good for a given patient, at a given computer node, for a given database management system. The token serves as a data access key to a particular pre-defined set of data. The token is used by a data gathering agent to access the authorized patient records of the requesting site. It is assumed that the necessary patient's medical records are stored local to the requesting site or that a listing of the sites previously visited by the patient can be obtained from the requesting site. These patient records are sent to the remote site if necessary and an access control table is updated on a patient by patient basis. The access control table defines the access privileges granted to the target remote user.

In addition to the use of access tokens, other security measures are implemented:

Access into review programs requires an issued user name and password.

All users are assigned various levels of access authorization using an authorization matrix.

Each clinical database user is restricted to pre-defined views to a subset of the database.

Encryption is applied to all data over the WAN. Encryption and decryption keys is under the control of the system administrator and periodically changed. Since the network messages are passed between programs not users, the staff personnel are not required to handle the encryption process directly. Good encryption software, including international versions, are available both commercially and at various sites on the Internet. They are generally based on the RSA algorithm, Data Encryption Standard (DES) or International Data Encryption Algorithm (IDEA). The RSA algorithm is an asymmetrical algorithm involving both a public and a private key. It is particularly attractive because it implements

confidentiality (verify the receiver), validation (the message is untampered), authenticity (verify the sender) as well as nonrepudiation (the sender cannot deny later that the information was sent). Each site can also have complete control over its own secret key. The most important security consideration in implementing encrypted communication is to protect all program source codes which contain the secret pass phrase. This is done by a) encrypting that part of the source code, b) providing a protective development environment, and c) developing administrative tools which only allows the system administrator to change the pass phrase.

Case Management: Once the patient's folder is prepared, a flashing icon is displayed on the electronic desktop of the referring consultant's computer indicating a new outstanding service request. It appears with the status message of "Pending request". The task of a Case Manager is to ensure that the consultation process moves forward seeing through the completion of the referral process according to time constraints, required information content and communication needed by the PCP from the specialist to coordinate and informing one another.

The Case Management Service consist of a set of software agents that are responsible for communicating and soliciting information to/from the PCP and specialist and from various database management systems participating within the system. The Case Manager is responsible for ensuring a high degree of coordination between the specialist and PCP (that is the specialist and PCP need to know what the other is doing for the patient if they are caring for the patient at the same time). This coordination is important because the consultant may begin ordering a series of tests without regard to the PCP's plans.

The Case Manager uses a "Surgical Team" model for cooperative coordination with other supporting agents. The "head surgeon" in this model is the Case Manager. It maintains an agenda and scheduling mechanisms. Scheduling involves both feasibility constraints and desirability criteria.

A team of agents supports the Case Manager. Each supporting agent performs well differentiated, specialized roles that provide the leader with expert support, swiftly and reliably. Case Managers are modeled as distributed, decentralized systems consisting of small competence modules. Each competence module is an "expert" at achieving a particular small, task-oriented competence.

The Case Managers interface with one another via extremely simple messages and based on a globally-defined protocol based on a postal metaphor. Each message is enclosed in an envelope structure, which is routed (transparently by the sender) to the mailbox mechanism of each recipient. Complex behavior is the result of interaction dynamics (feedback loops) at three different levels; interaction between the Case Managers and the environment, among the different modules inside the Case Manager, and among multiple Case Managers. A Case Manager may also be responsible for soliciting and/or gathering information from a user.

The Case Manager maintains two data structures: a Case State Table and a Case Agenda. The state table contains information regarding the current processing state of the patient. The case agenda table contains a checklist and a set of associated task-originated Case Managers to carry out the appropriate order and time limits. The Case Manager uses the supporting Case Managers to accomplish the various tasks associated with its assigned agenda.

Case Preparation: Upon receiving a service request for a given remote patient, the Case Manager service dispatches a Case Preparation agent. This Case Manager is responsible for retrieving medical records for the patient from the site of initial request and/or local records of the patient. It in turn communicates with the Data Gathering Layer of the architecture. The Case Preparation agent can be programmed to collect only the view of the patient's medical record. It can alternatively be programmed to collect an unfiltered view of the patient's medical record including HIS, RIS, and the system type information. The Case Preparation Agent compiles the given patient's records into a local DBMS (Lotus Notes Environment).

Update specialist Workstation Desktop: Upon the completion of the case preparation task, the Case Manager service updates the appropriate specialists workstation screen. An icon is created on the desktop of the workstation program that provides the specialist with up-to-date information regarding the status of the patient under his/her remote care. This includes whether a new patient request has been made, whether the patient is still in the hospital, what the patient is waiting for, and/or what operations are being performed on the patient.

In practice, when a number of specialists and health care workers are working on a single patient, the primary care provider inevitably becomes out of touch with some of the facts which may affect his/her decision-making. A centrally organized totalitarian system is inevitably inferior because the information flow to the decision-making center would always be at a lower rate than in a decentralized economy.

Project status reviews are used to ensure that the project is on track and to bring the different sources of expertise to bear on the problem simultaneously. Communications need to be explicit about what is being planned, what is being done, and who is going to do it. In addition, there needs to be some follow-up mechanisms to ensure that promised actions really are carried out. Large projects coordinate the efforts of large numbers of different people. The relationships between these people have to be formalized in some way so that things get done on time and to specification. Negotiation is necessary in any project to ensure that people make and keep their commitments. It is the means by which people agree to do certain things at certain times within the project.

Planning and scheduling is only a part of activity management. Monitoring of project performance is needed to ensure that quality requirements are met and that unexpected occurrences will not delay subtasks and lead to a new critical path and a delayed project. One of the goals of critical risk management is to detect likely deviations of functionality from requirements early on.

Critical risk management is based on the assumption that all projects involve choices and decisions. The critical risk management also supports the decision maker with the following information that is available throughout the project: (1) the risk of each component of the project, (2) the existence, time and budget for the project, and (3) new or changed requirements for the system. At all times, the Case Manager, the PCP and the specialist need to know the status and location of the patient. The PCP needs to know the types of additional exams requested by the specialist. The specialist needs to know the kind of information the PCP is expecting, the exact meaning of each information unit must be understood unambiguously by all parties (common data model must exist), how the PCP is expecting that the specialist will communicate this information.

The system provides several communication facilities to improve the cooperative and communicative requirements of remote consultations. For asynchronous communication:

E-mail services for non-urgent communications. E-mail systems are merged with scheduling, project management, in collaborative work tools.

Beeper services to notify the specialist and/or PCP of the occurrence of an important event and request.

For synchronous communication (i.e., real-time person-to-person communication):

Real time video conferencing uses the public domain software "CUgSeeMe" developed at Cornell University. This form of communication is the most powerful since in face-to-face meetings, we speak, make eye contact, and observe each other's facial expressions and gestures. These verbal and nonverbal channels are important in building confidence and establishing trust. A videophone and video conferencing has been the creation of interpersonal spaces that maintain a sense of telepresence or being there through the visibility of gestures and facial expressions of distributed group members.

The above description of preferred embodiments the present invention are for illustrative purposes. Variations will be apparent to those skilled in the art. Therefore, the present invention is not intended to be limited to the particular embodiments described above. The scope of the invention is defined in the following claims.

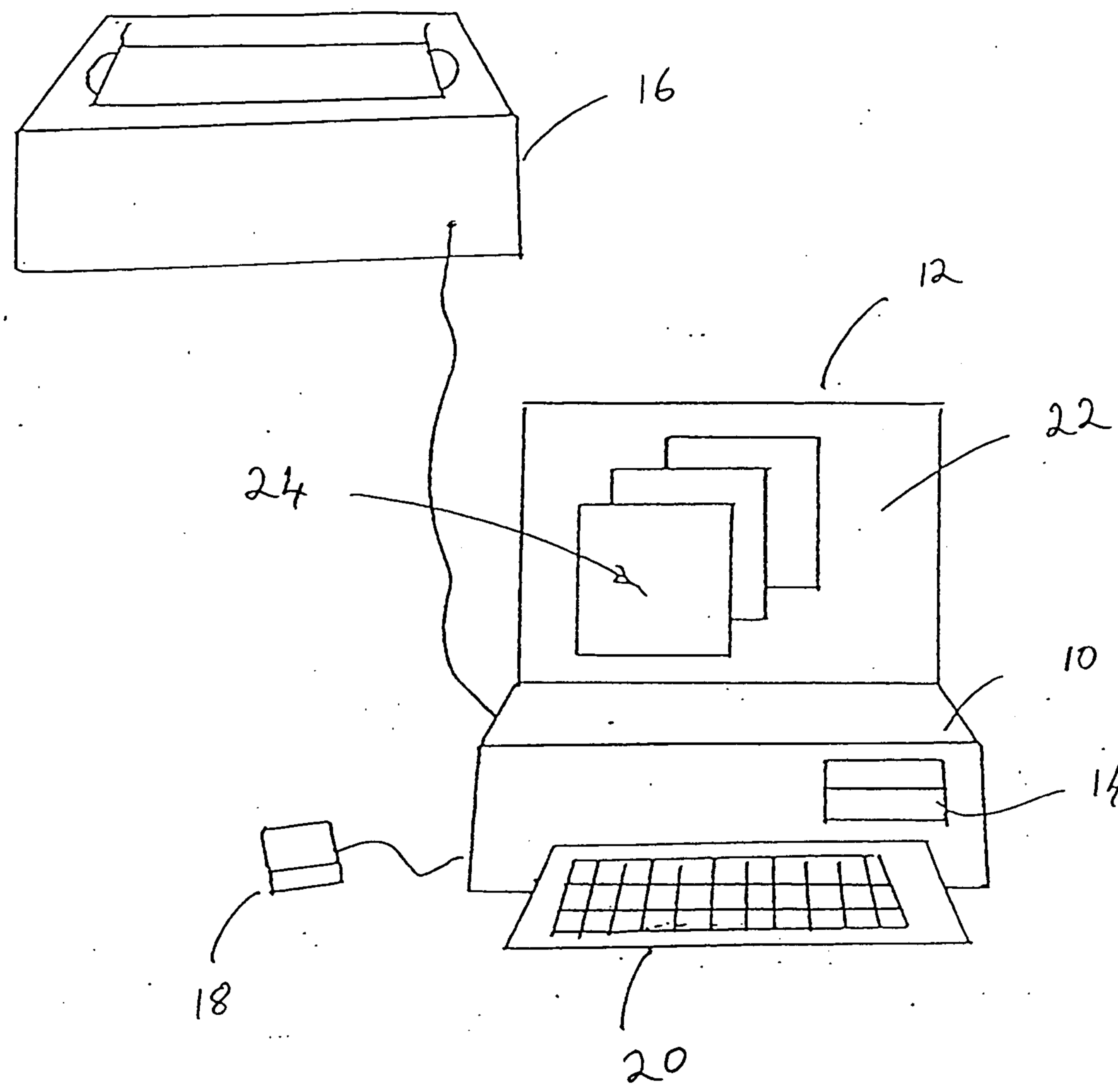

Fig. 1

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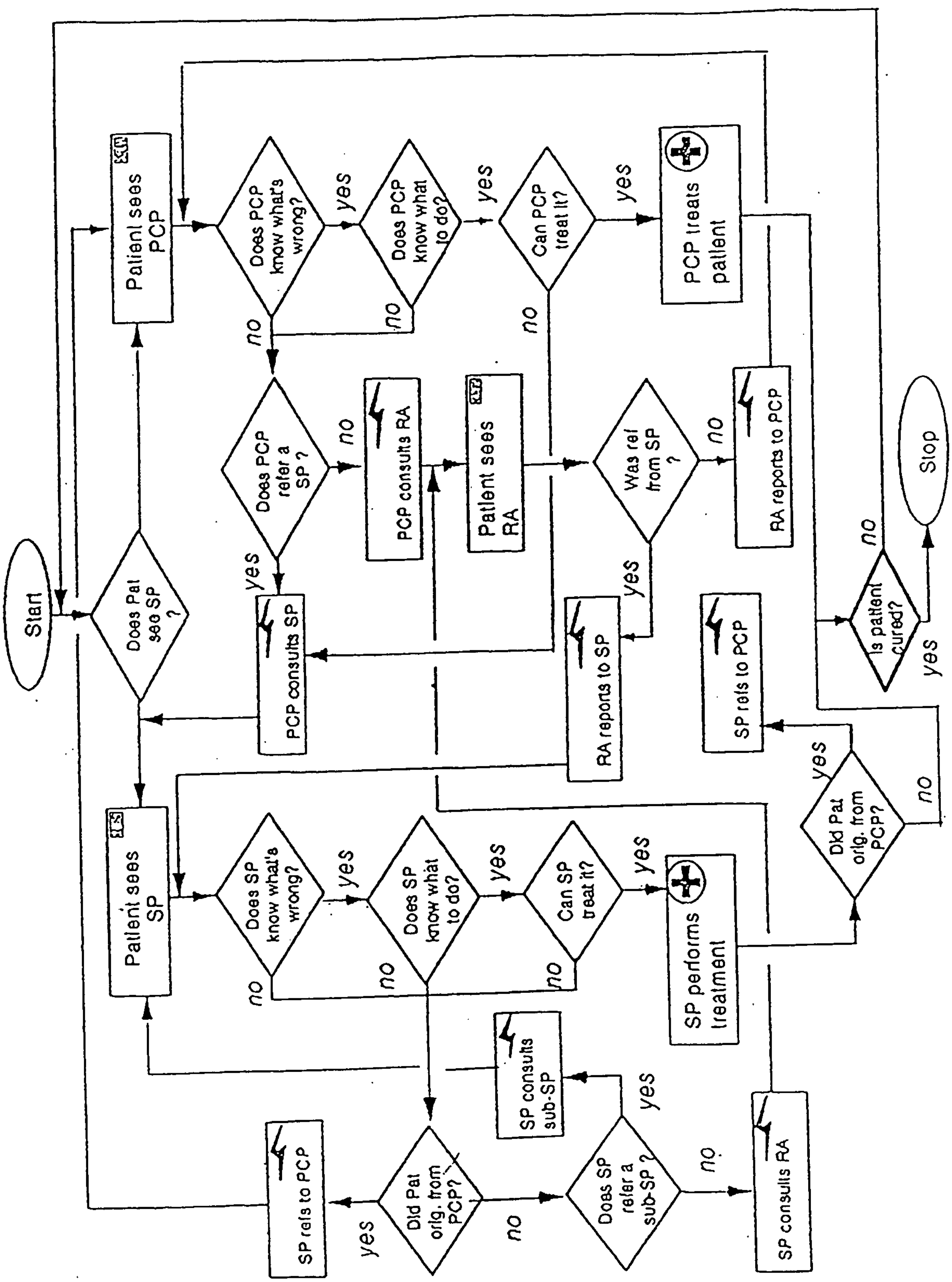

Fig. 2

Flow Chart
Primary Care Gatekeeper

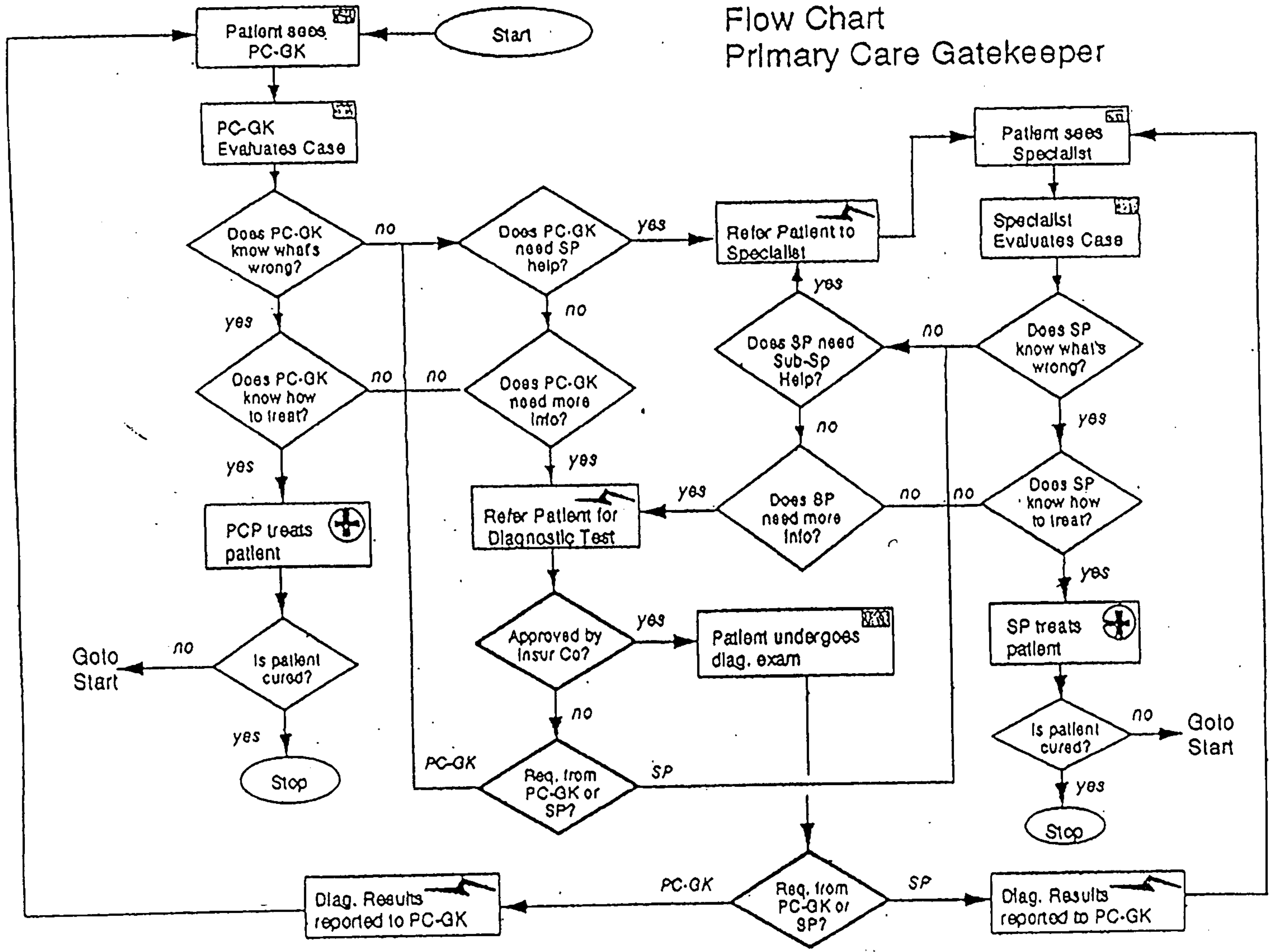

Fig 3

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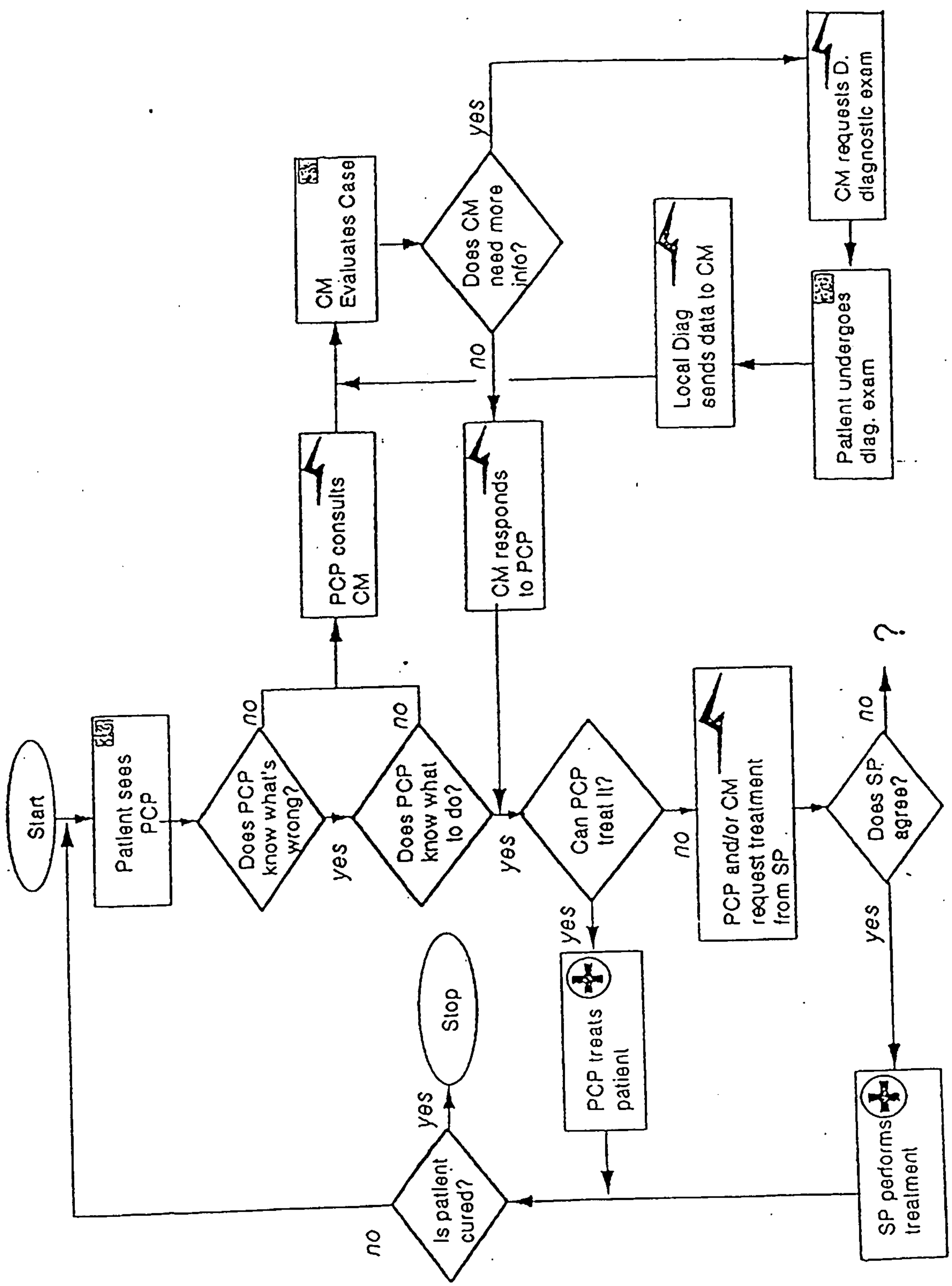
Fig 4



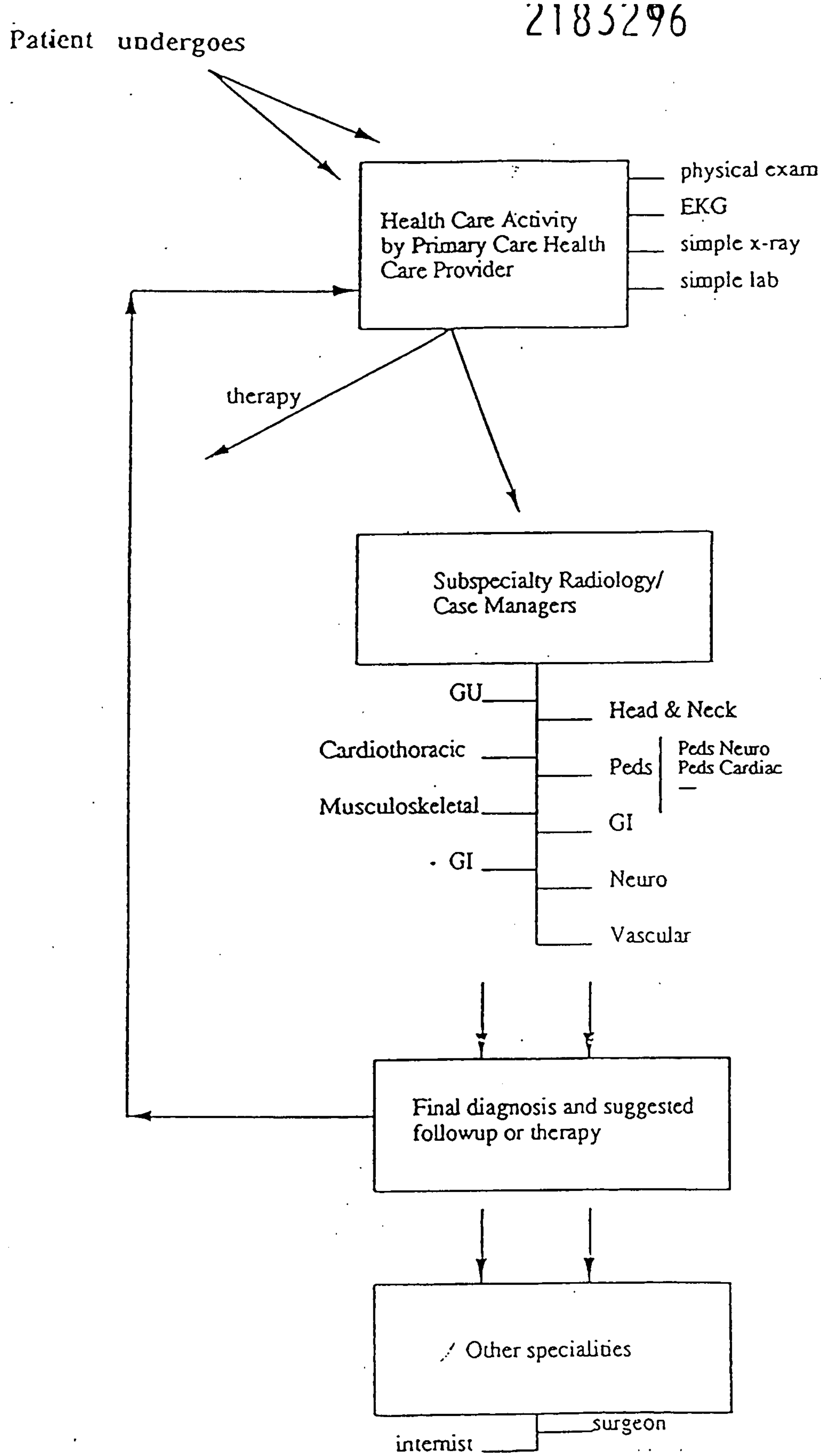
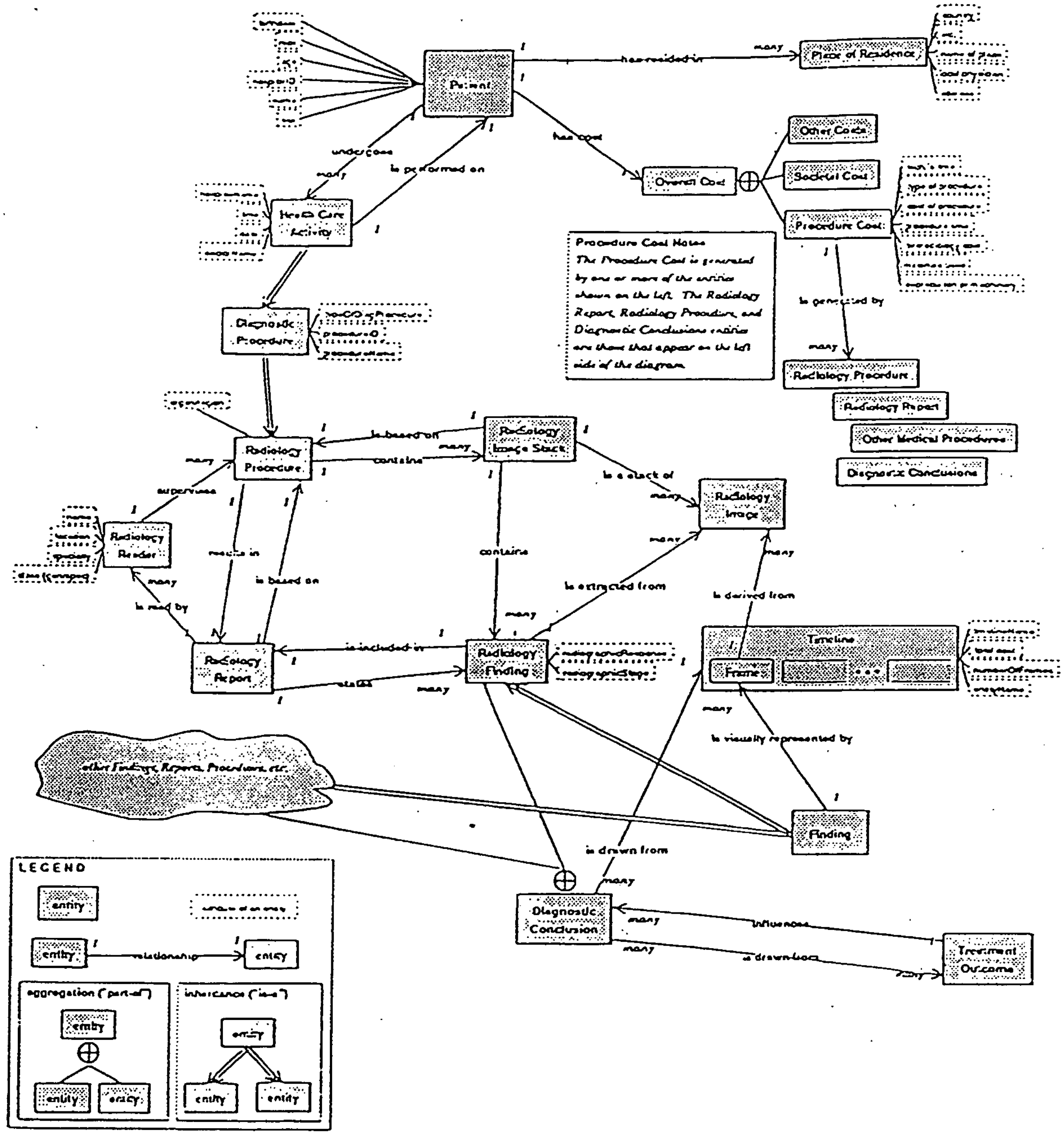
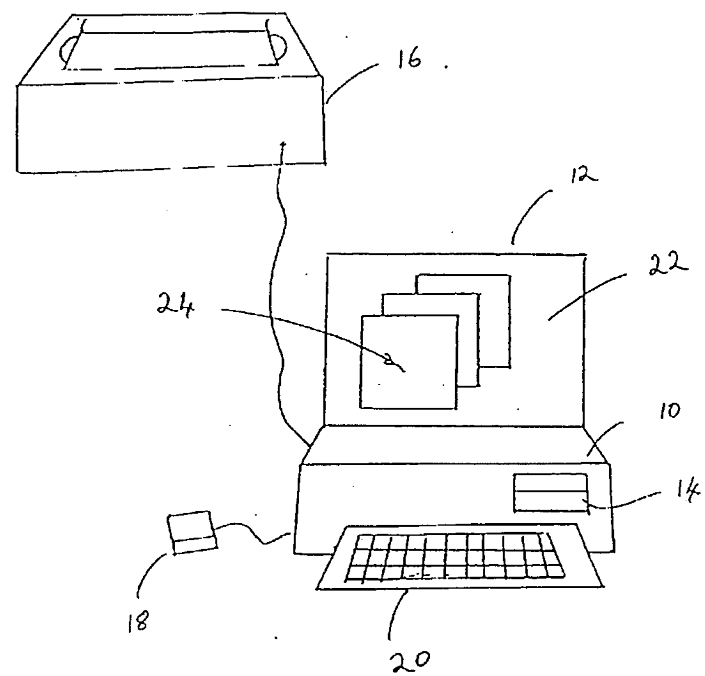

Patient undergoes
Health Care Activity by Primary Care Health Care Provider
physical exam
EKG
simple x-ray
simple lab
therapy
Subspecialty Radiology/ Case Managers
GU
Cardiothoracic
Musculoskeletal
GI
Head & Neck
Peds
Peds Neuro
Peds Cardiac
GI
Neuro
Vascular
Final diagnosis and suggested followup or therapy
Other specialities
internist
surgeon

Fig 5



Patient
has resided in
many
Place of Residence
has cost
Overall Cost
Other Costs
Societal Cost
Procedure Cost
undergoes
many
is performed on
Health Care Activity
Diagnostic Procedure
Procedure Cost Notes
The Procedure Cost is generated by one or more of the entities shown on the left. The Radiology Report, Radiology Procedure, and Diagnostic Conclusions entities are those that appear on the left side of the diagram.
is generated by
many
Radiology Procedure
Radiology Report
Other Medical Procedures
Diagnostic Conclusions
is based on
contains
Radiology Image Stack
is a stack of
Radiology Image
supervises
Radiology Reader
results in
is based on
contains
is read by
is extracted from
is derived from
Radiology Report
is included in
states
Radiology Finding
Timeline
Frame
is visually represented by
other Findings, Reports, Procedures, etc.
Finding
is drawn from
Diagnostic Conclusion
influences
is drawn from
Treatment Outcome
LEGEND
entity
relationship
aggregation (part-of)
inheritance (is-a)

Fig 6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